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INTERIM DEVELOPMENT REPORT

for

APPLICATION OF NEW MATERIALS AND TECHNIQUES IN ELECTRON GUN FABRICATION

This report covers the period of **7-1-61** to **9-30-61**

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INTERIM DEVELOPMENT REPORT

FOR

APPLICATION OF NEW MATERIALS AND TECHNIQUES IN ELECTRON GUN FABRICATION

This report covers the period 1 July 1961 to 30 September 1961

GENERAL DYNAMICS/ELECTRONICS
Information Technology Division
1895 Hancock Street, San Diego 12, California

NAVY DEPARTMENT BUREAU OF SHIPS ELECTRONICS DIVISION

CONTRACT NUMBER NObsr-81208 INDEX NUMBER SR0080302, S. T. 64

15 November 1961

ABSTRACT

Additional 5AQP7 Phase I tubes have been made and tested. The results compared with the original tube sent to the Bureau of Ships. Unforeseen problems, which delayed production of Phase II gun parts, have been solved. Delivery is expected in the very near future. Experiments pertinent to Phase III of the program have been conducted.

PART I

1. PURPOSE

The purpose of the program is to conduct a research and development project that will seek to employ new materials and apply new techniques to the production of cathode-ray tube guns in order to overcome present limitations in ruggedness and precision. The ultimate goal is to produce electron guns by precision molding or machining. The work includes three phases:

a. Phase I - Design and produce molded parts to make cathode-ray tube guns of the split cylinder type, and develop pilot tubes using these guns. Explore techniques and materials related to this effort including machined electron guns for testing these materials and techniques.

b. Phase II - Develop tube structures composed of complete cylinders employing circumferential grooves to position the various gun elements. Produce the tooling to form the grooves and fabricate the special apertures required. Pilot tubes will be submitted for appraisal.

c. Phase III - Work toward the development of a CRT gun which is a unitized structure. The gun will, if possible, become an integral part of the tube envelope.

2. GENERAL FACTUAL DATA

a. Identification of Engineering Personnel

Name	Title	Man-hours
E. C. Gear	Senior Chemical Engineer	398.0
R. H. Schmeling	Research and Development Technician	366.8
A. C. Corbett	CRT Technician "A"	6.0
J. S. Holt	Glass Worker	9.0
C. V. Hook	Internal-Coating Operator	8.0
A. F. Heinrich	CRT Technician "B"	4.0
C. T. Bradford	Engineering Assistant	4.0
W. Roe	Associate Engineer, Publications	12.0
L. Hammond	Engineering Illustrator	2.0
	Total	809.8

b. Patents - No existing patents are being applied to the problem.

c. References - No references were utilized during the report period.

3. DETAIL FACTUAL DATA

a. Introduction - Additional tubes of the Phase I, 5AQP7, split cylinder type have been completed and tested. Phase II remains uncompleted because the vendor has been unable to deliver molded parts. Experiments into various techniques required on Phase III have been conducted. The results of the experiments will be helpful in determining the most practical approach to a completely ruggedized gun.

b. Phase I Molded Split Cylinder Gun - In addition to the one previously shipped, more tubes of the split cylinder 5AQP7 type have been produced. The characteristics of these tubes have been thoroughly explored and the results compared with those obtained by Mr. Monns Turntine, Jr., at the Brooklyn Navy Yard. The majority of performance factors compare well with those of a conventional 5AQP7. Those factors that are not within specification are capable of rather simple corrective measures. The single exception is the focus voltage which remains high and may prove to be characteristic of formed guns; see Appendix A. It was gratifying to learn that the tube had met military specifications for shock and vibration, since full realization of the ruggedness capability of formed gun techniques will not occur until Phase II and III.

c. Phase II Complete Cylinder Gun - Previous reports have indicated that molded Phase II gun parts would be delivered about the end of July. These parts have not yet been received. Past experience with the vendor has indicated some laxity in meeting delivery schedules, but they have given us excellent cooperation in producing the unusual molded parts required on the program. Their explanation of the delivery problem is as follows:

The difficulty is not due to the design of the molded piece. However, the configuration of the part requires that a long, relatively slender, core pin be withdrawn from the molded piece. In high production molds this operation is performed hydraulically but a simpler method of withdrawal could result in a large saving of time in mold construction. The simpler method was employed, but resulted in the breakage of several core pins. Considerable time was lost and further time was expended in revising the mold so that hydraulic operation was possible. Some further molding difficulties were experienced after the revision, but parts are expected in the near future.

d. Phase III Completely Ruggedized Tube - The delay in receipt of Phase II molded parts has allowed time for several experiments related to Phase III of the program. The results have served to establish some useful techniques applicable to Phase III and to more firmly establish the most practical approach.

Metal Envelope - A metal tube envelope has been fabricated. The neck and funnel were formed from high chrome iron and were then assembled into a unit by Heliarc welding. Plans for the completed tube include a frit sealed face plate and a stem sealed in place by conventional methods. Short sections of glass tubing have been successfully sealed to the metal tube neck in order to reduce the diameter so that it matches the stem. The addition of the stem results in a highly stressed seal that fractures a short time after completion. A longer section of glass tubing would alleviate the problem, but at a sacrifice in ruggedness. The success of the frit sealed tube face is also problematical. Proper tooling in conformance with standard practice would assure the production of these tubes, but the expense is not warranted at this time.

Glass Bonded Mica Stem - Glass tubulations have been sealed with glass frit to pieces of glass bonded mica. They appear to be sound, but leakage is evidenced in tests with a helium leak detector. It has been established that leakage occurs through the glass bonded mica, and the usefulness of the seal is, therefore, in doubt. Successful hermetic seals with glass bonded mica have been reported and it is probable that proper selection of material would lead to a solution.

e. Project Performance and Schedule - As Figure 1 indicates, Phase I has been completed and evaluation of the resultant tubes has been made. Phase II gun parts have not been received due to molding problems. These problems have now been resolved and early delivery of parts should allow rapid completion of Phase II. Phase III should be concluded shortly thereafter.

4. CONCLUSIONS

Phase I split cylinder electron guns have been evaluated from the operational standpoint. They give satisfactory performance on both electronic and mechanical tests, although minor performance differences do exist. Broken mold parts have seriously delayed delivery of Phase II guns, but the difficulties have been corrected and delivery is expected in the near future. Much of the experimental work on Phase III has been completed.

GENERAL DYNAMICS/ELECTRONICS
Information Technology Division

PROJECT PERFORMANCE AND SCHEDULE
INDEX NO. SR0080302, S. T. 64

DATE : NOVEMBER 15, 1961

CONTRACT NO. NOBSR-81208

PERIOD COVERED: 7/1/61 TO 9/30/61

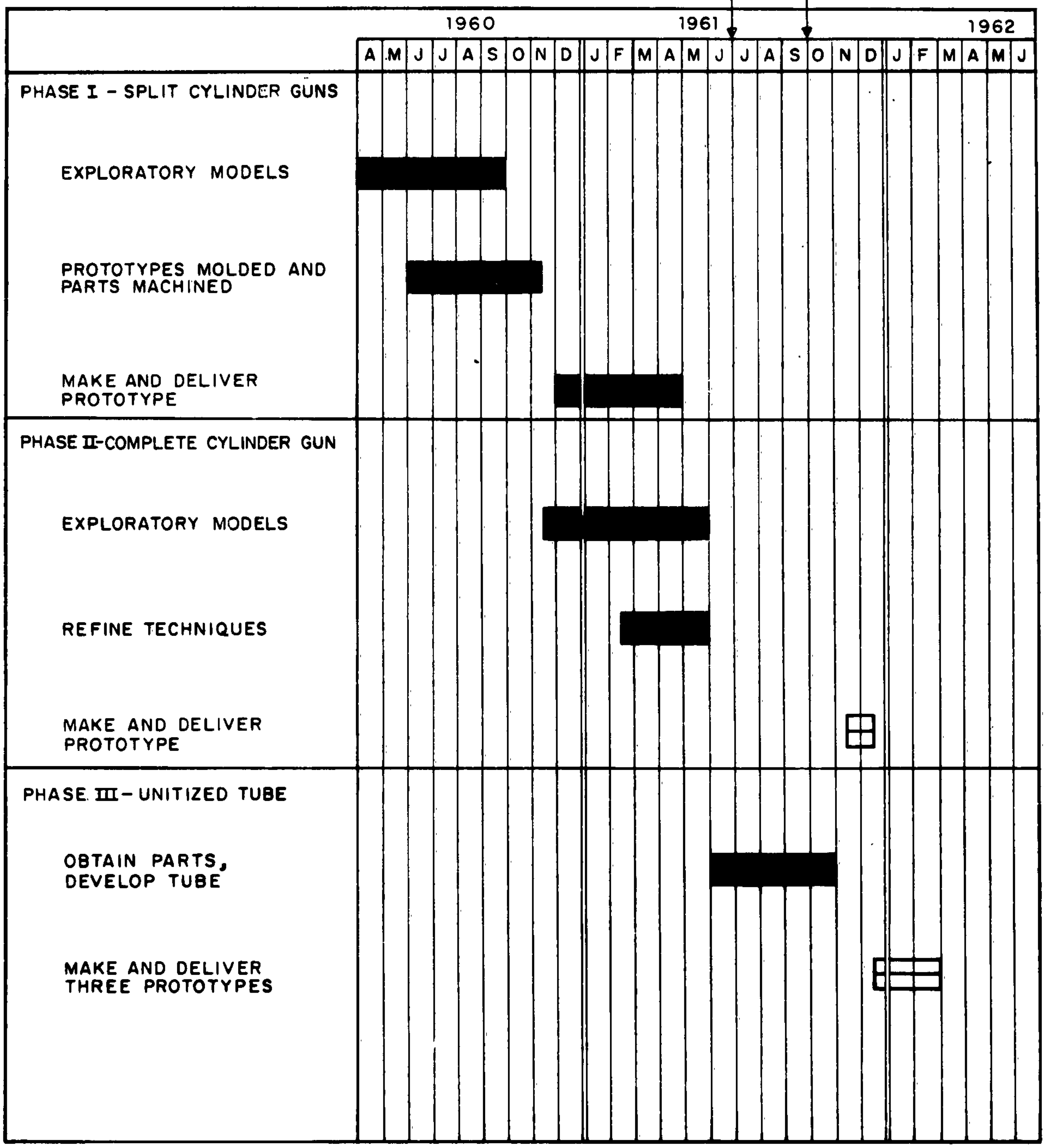

Figure 1 - Project Performance and Schedule Chart (Sheet 1 of 2)

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LEGEND

— WORK PERFORMED

— SCHEDULE OF PROJECTED OPERATION

ESTIMATED COMPLETION IN PERCENT OF TOTAL EFFORT EXPECTED TO BE EXPENDED

PHASE I - SPLIT CYLINDER GUNS	
EXPLORATORY MODELS	100%
PROTOTYPES MOLDED AND PARTS MACHINED	100%
MAKE AND DELIVER PROTOTYPE	100%
PHASE II - COMPLETE CYLINDER GUN	
EXPLORATORY MODELS	100%
REFINE TECHNIQUES	90%
MAKE AND DELIVER PROTOTYPE	75%
PHASE III - UNITIZED TUBE	
OBTAIN PARTS, DEVELOP TUBE	50%
MAKE AND DELIVER THREE PROTOTYPES	0%

Figure 1 - Project Performance and Schedule Chart (Sheet 2 of 2)

PART II

PROGRAM FOR NEXT INTERVAL

Phase II gun parts will be received and will allow the rapid conclusion of this phase. A large share of the experimental work on Phase III has been performed and should allow an early completion of Phase III.

PART III

APPENDIX A

This appendix consists of portions of a previous monthly report, which are pertinent to this quarterly report. The appendix contains a summary of the test results at Brooklyn navy yard, the test results at General Dynamics/Electronics - San Diego, and the specified characteristics of a 5AQP7 tube. A brief discussion is included of the probable cause and correction of factors that are outside of specifications.

High interelectrode capacitance D3 to D4 and to other parts of the gun:

In order to insure structural soundness in the split cylinder molded gun the D3 and D4 plates are the same size as the D1 and D2 plates. To simplify the application of the conductive coating the surfaces of D3 and D4 were covered completely with the conductive material, and this procedure results in D3 and D4 having about the same area (and capacitance) as D1 and D2. This capacitance can be cut down in a relatively simple fashion by masking the plates so that they have the same conductive area as do the plates in the conventional 5AQP gun.

Bright areas in raster pattern:

This is felt to be due to the fact that the deflection plates (particularly D1 and D2) are not identical in configuration to a typical 5AQP gun. The The split cylinder molded gun was designed with excess material on the mating surfaces so that these surfaces could be ground to an exact match. Some excess was also allowed for in the deflection system.

The areas of the plates parallel to the axis of the gun have been ground to obtain the specified spacing between plates, but expensive fixtures are required to grind the angular areas of the plates. In a feasibility study we felt this effort was excessive and consequently the angular sections of the plates have not been ground. This results in a longer than normal parallel section of the plates while the angular portion of the plates is shorter than normal. Consequently the electron beam strikes the parallel plate areas when maximum deflection is employed. (The appearance of the bright streak is coincident with the detection of plate current.) Correction of this difficulty is believed simple, and will entail some additional expense.

Spot Displacement:

Spot displacement has been negligible in the tubes tested here. Improved assembly techniques have probably corrected this factor.

Comparison of the tube sent to BuShips and evaluated at
Brooklyn Navy Yard, and another tube evaluated at GD/E

		Navy Yard	GD/E	Min.	Max.
4.9.2.1	Dimensions	S	S		
4.6.1	Preheating	S	S		
4.10.8	Heater Current	620	585	540	660 ma
4.12.1.1	A1 Current	-6	11	-15	15 uadc
4.12.1.1	A2 Current	230	100	---	350 uadc
4.12.1.1	Cathode Current	150	260		1000 uadc
4.12.1.1	Voltage Breakdown	S	---		
4.12.2.1	Gas Cross	S	---		
4.12.3.1	Base Alignment	S	S	---	10 degrees
4.12.3.7	Angle between traces	90.4	--	89	91 degrees
4.12.5.1	Blemishes	S	--		
4.12.5.3	Modulation	24	56*	---	40 vdc
4.12.6.1	Line Width A	.50	.367	---	.75 mm
4.12.6.1	Line Width B	.60	.395	---	.80 mm
4.12.7.2	Spot Position	2	2.6	---	16 mm
4.12.7.3	Spot displacement	19*	.5	---	10 mm
4.12.9	Grid Cutoff volt	-52	-66	-47	-79 vdc
4.12.10.1	Focus Voltage	760*	760	0	420 vdc
4.12.10.2	Focus Voltage	710*		6	420 vdc
4.12.11	Deflection Factor 1D2	63	52.5	57	69 vdc
4.12.11	Deflection Factor 3D4	49	45	44	54 vdc
4.12.12	Deflection Factor Uniformity 1D2	.96			1%
4.12.12	Deflection Factor Uniformity 3D4	.48			1%
4.12.13.1	Heater Cathode Leak	0	4		10 uadc
4.12.13.2	Grid #1 Leak	0	.2	---	3 uadc
4.12.13.4	Anode #1 Leak	1		---	5 uadc
4.12.13.5	Anode #2 Leak	10*	1	---	5 uadc
	Light Output	22			Ft. L.
4.10.14	Capacitance				
	Cathode to all	4.1	4.8	---	5 uuf
	Grid to all	6.9	6.7	---	6.9 uuf
	D1 to D2	3.3	8.0*	---	4.5 uuf
	D3 to D4	3.4*	8.2*	---	1.6 uuf
	D1 to all	8.4	9.5	---	9.3 uuf
	D2 to all	8.4	9.0	---	9.3 uuf
	D3 to all	8.6*	9.5*	---	6.3 uuf
	D4 to all	9.1*	9.5*	---	6.3 uuf
	Centering of beam 1D2	S		±2"	useful scan
	Centering of scan 3D4	S		±2"	useful scan
	Pattern Distortion	S			
4.12.4.1	Cathode Illumination				0.154 m ft. L.

Factors outside of specifications (*)
Our capacitance readings are believed to be high.